Chapter Two

Integrated Resource Planning

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Dramatic changes in the electric utility industry since the early 1970s have created a need for more sophisticated planning tools to guide utility resource decisions. Today's integrated resource planning process has improved the concept of least-cost planning, which was introduced in the mid-1980s.

The best industry practices in integrated resource planning include looking at a broad range of supply-side and customer service options, using multiple evaluation criteria, involving the public, and considering uncertainty associated with future events.

TVA's approach to integrated resource planning has built on these best practices. It also includes more extensive planning interaction with stakeholders and with technical experts inside and outside TVA. Energy Vision 2020 also goes beyond the traditional regulatory focus on least-cost plans and demand-side management to consider the growing issue of competition and its potential effects on resource decisions.

This Chapter Includes:

- Integrated Resource Planning History
- Integrated Resource Planning Process Overview
- TVA's Approach to Integrated Resource Planning

Integrated Resource Planning

Integrated Resource Planning History

Through the 1960s, planning for the future in the electric utility industry was straightforward. Growth in the demand for electricity was consistently strong. This allowed for continuing economies of scale for power plant construction, which kept driving down the cost of incremental resource additions. Therefore, electricity rates stayed constant, and during some time periods, actually decreased. Planning consisted primarily of determining the schedule for adding large, bulk-power generators to the system to meet rapidly increasing loads. Simple trending techniques seemed to be sufficient guidance to questions about future resource requirements.

All of this changed dramatically in the 1970s as many factors produced significant volatility in the electric power industry's cost structure. These included the Arab oil embargo, rampant inflation, the regulatory consequences of the Three Mile Island incident, and air emission controls on power plants. As a result of these events, electric rates began to increase significantly, load growth slowed, and the future became far less predictable. In addition, competitive wholesale generation markets began to emerge as a result of the Public Utilities Regulatory Policy Act of 1978. By the 1980s, energy conservation evolved into the concept of demand-side management, focusing on the long-term efficient use of resources. All of these issues required new planning approaches and techniques to help utilities integrate these changes into their planning process.

Least-cost planning, with its emphasis on end-use efficiency, was introduced in the mid-1980s to help address these issues. Least-cost planning has evolved into the concept of integrated resource planning defined in the National Energy Policy Act of 1992. Integrated resource planning is continuing to change to meet the increasingly competitive environment in the electric utility industry.

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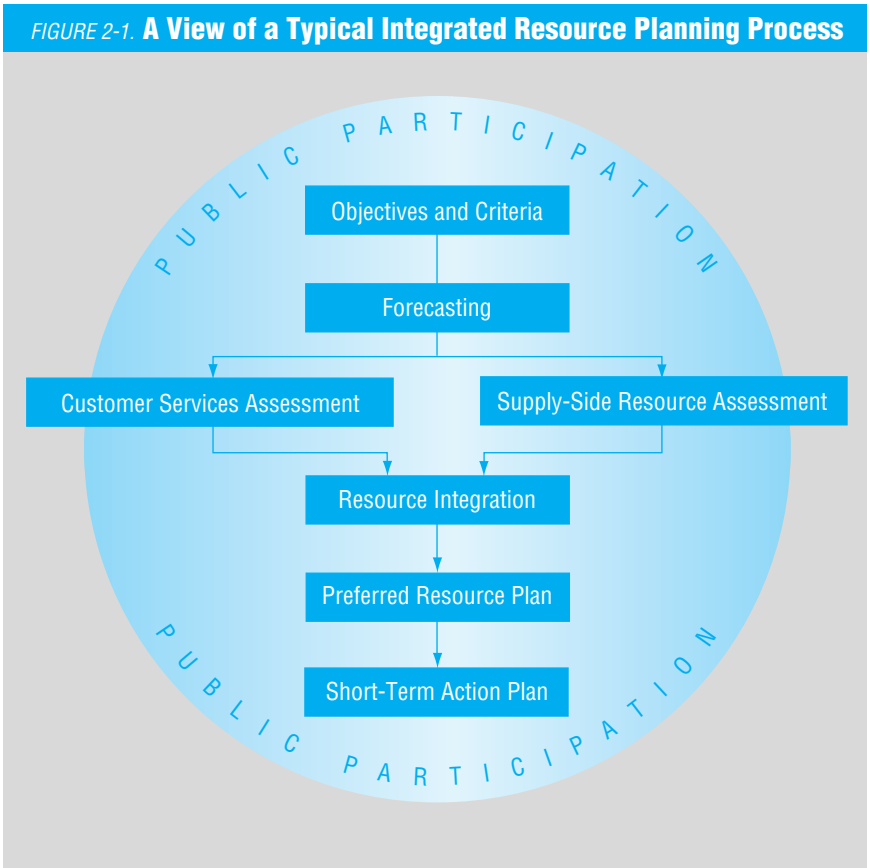
Integrated Resource Planning Process Overview

An effective integrated resource planning process results in a plan that broadly identifies the long- and short-term actions a utility anticipates undertaking to meet future demands for energy services and to achieve its objectives. The integrated resource planning process evaluates both supply-side options

FIGURE 2-1. **A View of a Typical Integrated Resource Planning Process**



and customer service options. Supply-side options refer to various methods for generating or acquiring additional electrical energy. Customer service options encompass a wide range of technologies, programs, pricing strategies, and other activities that change the way consumers use electricity. Consumer actions improve the value of energy services. They can also provide resource benefits for the power system by avoiding the need to build or otherwise acquire supply-side resources.

A typical integrated resource planning process is illustrated in *Figure 2-1*. A utility must first look at its objectives and the issues affecting its operations, then develop evaluation criteria consistent with its objectives. These criteria are used as a guide in evaluating its energy resource options. The utility next looks at its projected need for power, which includes the utility's load forecasts and an assessment of its existing power system to meet the projected loads. If a need for new resources is identified, the utility evaluates potential supply-side and customer service resource options to meet these needs.

Integration is an interactive process that evaluates specific combinations of existing and new resource options called strategies. These strategies are evaluated based on the utility's evaluation criteria and future uncertainties that may affect resource choices. After the utility evaluates all its resource options and strategies against its criteria, it chooses a long-term resource strategy or plan that adequately and reliably meets its projected need for power and other customer services. A preferred plan is one that will score well on as many of the evaluation criteria as possible and will provide the utility with the necessary flexibility to deal with future uncertainties.

A good integrated resource planning process also yields the utility's short-term action plan. This plan lists the specific steps the utility will take in the next three to five years to support its long-term plan. For example, if the preferred long-term plan calls for an additional power plant in the future, the short-term action plan would include acquiring a site for the plant.

Some of the best practices used by leading electric utilities in preparing integrated resource plans include:

- Identifying a broad range of supply-side and customer service options and their unique operating characteristics.
- Using multiple evaluation criteria that include total cost and rate impacts, environmental impacts, and risk management to compare specific resource plans or strategies. To these standard evaluation criteria, TVA added a measure of economic value, which broadens the range of options considered in the planning process.
- Integrating multiple perspectives through a variety of public participation techniques designed to receive and consider the comments of the general public and "stakeholders."
- Incorporating uncertainties into the planning process, such as the uncertainty associated with the future demand for electricity, fuel prices, and the enactment of future environmental regulations. These uncertainties have the potential for dramatically changing a utility's future course of action. Several analytical techniques allow utilities to consider such uncertainties and build flexibility into their plans.

TVA's Approach to Integrated Resource Planning

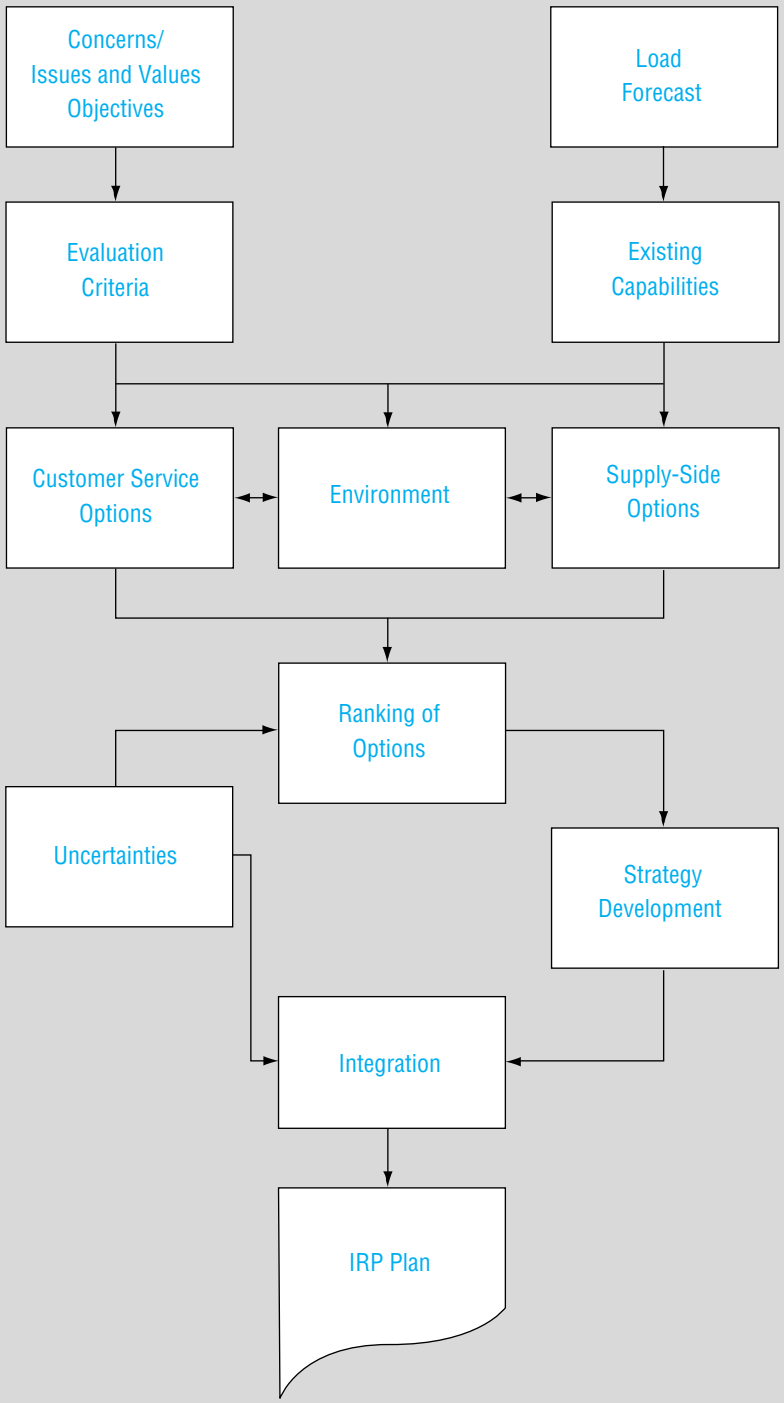
TVA's Energy Vision 2020 has incorporated the best industry practices and added several improvements to meet its unique situation and the changing utility environment.

First, TVA developed a highly interactive planning process to build Energy Vision 2020. This included a great deal of interaction between TVA and its stakeholders, and among stakeholders themselves. Also, there was extensive involvement from a broad cross-section of TVA staff, who have technical expertise and program responsibilities for the areas covered by integrated resource planning. They worked in different building block teams for each step of the process identified in *Figure 2-2*. Each team had members that not only represented the primary staff responsible for a technical area, but other members who could help the team understand issues or concerns from other perspectives (e.g., customers, environmental).

This process of increasing involvement by TVA stakeholders and employees has expanded the general awareness of the highly complex issues associated with utility decision-making. It will also help in building an understanding of the decisions the TVA Board of Directors will make concerning TVA's long- and short-term resource plans.

Second, most utility integrated resource plans to date have focused on meeting their business objectives in a regulated environment and on meeting regulatory commission standards and expectations. To go beyond best industry practices, Energy Vision 2020 focused on meeting customer expectations, while recognizing the potential challenges of a less regulated electric utility environment.

FIGURE 2-2. **Energy Vision 2020 Building Blocks**



This figure illustrates only the primary flow of information in developing Energy Vision 2020 and not the full process of building block interactions and feedbacks on common issues.

INTERACTIVE PLANNING

Interactive planning moves from the identification of issues and concerns to the development of preferred strategies. An interactive approach requires:

1. Identifying public issues and relevant concerns
2. Translating public issues and concerns into evaluation criteria, resource options, and uncertainties
3. Crafting resource options into strategies
4. Identifying possible future conditions (uncertainties)
5. Constructing scenarios
6. Using trade-off analysis to find the best strategies for the future

Value judgments about the importance of potential impacts from various resource options (e.g., on cost, rates, the environment, TVA's debt) are intentionally deferred until later in the process, when extensive discussions take place about making trade-offs among issues people value. Although TVA has had discussions with its stakeholders about the possible trade-offs among different values, the decision-making authority ultimately resides with TVA's Board of Directors. The Board is responsible for deciding which short-term and long-term energy strategy TVA will adopt to best serve its customers and meet the agency's other goals.

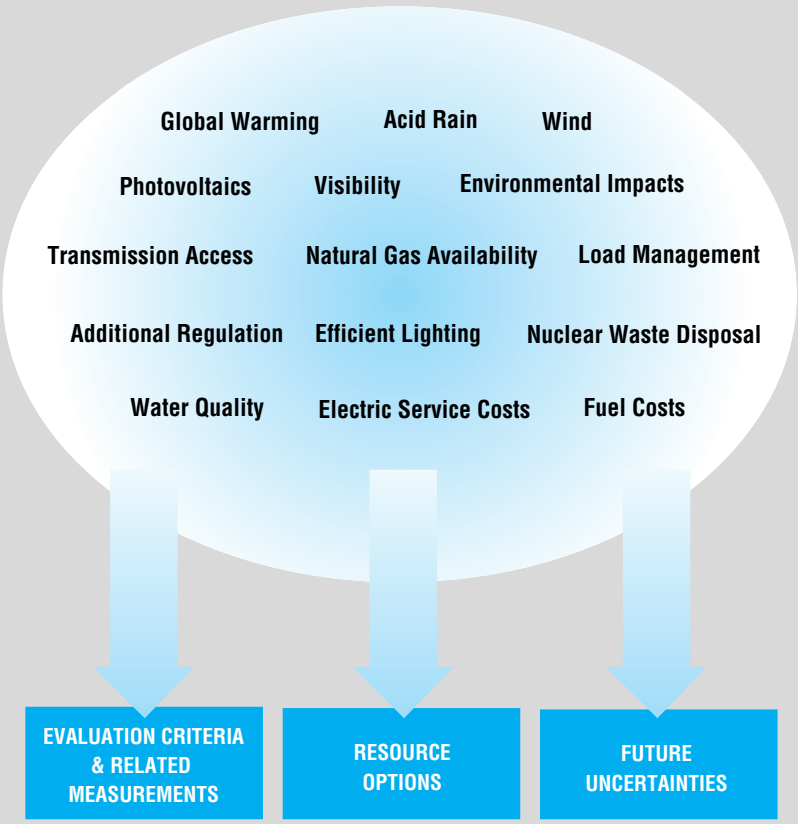
TVA'S IMPLEMENTATION OF THE INTERACTIVE PLANNING PROCESS

Below is an outline of TVA's movement through each step to the development of preferred strategies.

Step 1: Identifying Public Issues and Relevant Concerns

The objective in the early stages of the planning process was to accumulate as many relevant issues and concerns as possible from customers, TVA employees, environmental groups, and other key stakeholders. Some of these concerns are illustrated in *Figure 2-3*.

FIGURE 2-3. **Translating Public Concerns**



Issues and concerns from the public were translated into evaluation criteria, resource options, and future uncertainties used in Energy Vision 2020.

Step 2: Translating Public Issues and Concerns into Evaluation Criteria, Resource Options, and Uncertainties

TVA then categorized each issue or concern so that it could be systematically discussed and evaluated. This meant stating issues or concerns in a way that would allow as much quantitative evaluation as possible in the planning process. Quantitative evaluation provides a fact-based or numerical value system upon which to base decisions, and it reduces the subjective debate that can surround various issues or concerns.

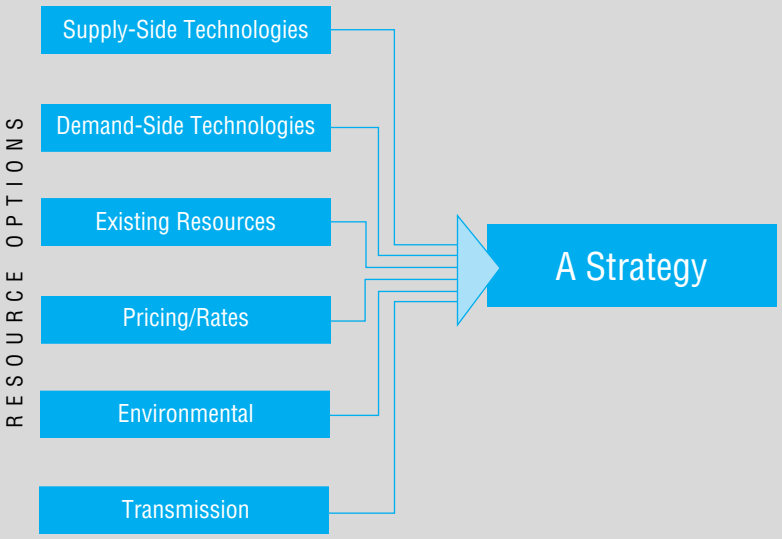
TVA translated concerns about the Valley's energy future into the following categories:

Evaluation Criteria and Measurements

Statements that reflected TVA and stakeholder values were translated into evaluation criteria. For example, impacts on rates and the environment are important considerations that TVA needs to consider in evaluating various future resource strategies. TVA then identified attributes that could be used to measure various impacts. For example, if there is a concern that development of a resource will cause rates to increase too much, the attribute could be the projected level of TVA's rates by a certain year. If an environmental concern is greenhouse gases, the attribute could be the amount of carbon dioxide emitted by that resource option over the planning period.

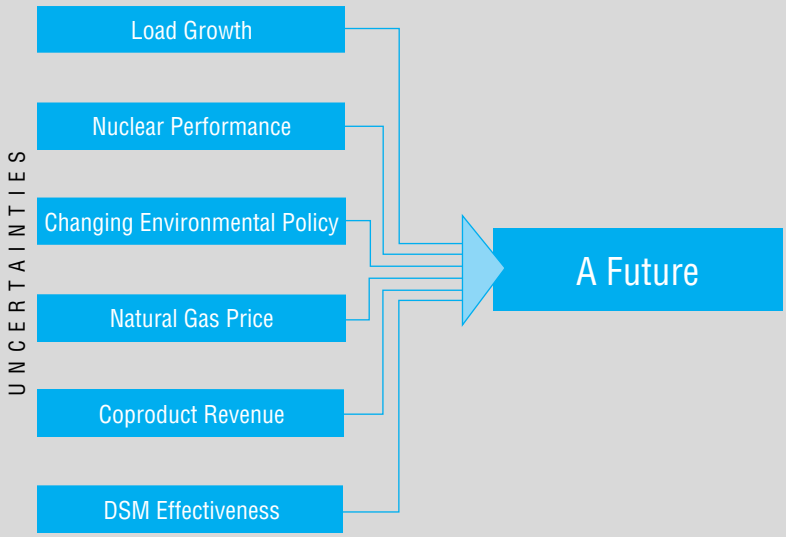
For some of the criteria, TVA established constraints as minimum and/or maximum bounds of acceptable performance. For example, if the concern is

FIGURE 2-4. **Creating Strategies**



Strategies were developed by combining resource options.

FIGURE 2-5. **Creating Futures**



Futures were developed by combining uncertainties of greatest concern.

the reliability of electricity, a constraint may be given in terms of minimum expectations for power quality or duration of power outages. For an environmental concern, such as greenhouse gases, a constraint may set a limit on the amount of carbon dioxide emissions a generating option may produce in a given time period.

See Chapter 5 for a detailed discussion of evaluation criteria, measurements, and constraints used in Energy Vision 2020.

Resource Options

Resource options grew out of suggested actions that stakeholders and others consider to be within TVA control and should be taken by TVA to meet its objectives, satisfy customer needs, and/or resolve issues. For example, if the issue is a shortfall in power supply in the year 2007, a suggested action or option for TVA could be to build a power plant to meet the demand. Another might suggest TVA pursue demand-side management programs to reduce consumer demand. More information about the supply-side and customer service options TVA considered in Energy Vision 2020 can be found in Chapters 7 and 8.

Uncertainties

Issues or concerns that may affect energy resources in the future but are beyond TVA's control are termed uncertainties. An example would be the future level of natural gas prices. This uncertainty is significant because natural gas is a source of fuel for power plants, as well as an alternative to electricity for some consumer needs. Critical uncertainties considered in TVA's integrated resource planning process can be found in Volume 2, Technical Document 8, Resource Integration.

Step 3: Crafting Resource Options into Strategies

After categorizing public concerns, TVA began identifying and characterizing resource options, ranking them based on costs, rates, debt, and environmental emissions, and screening out those that were clearly not feasible. *Figure 2-4* shows how the selected options were combined into a strategy to meet projected load and other criteria, as well as to address key uncertainties. More information on the development of specific strategies can be found in Chapter 9, Resource Integration/Alternative Strategy Comparisons.

Step 4: Identifying Possible Future Conditions (Uncertainties)

From the list of concerns that were translated into uncertainties, possible futures were defined. A future is a combination of one or more uncertain events. For example, a future could include high growth in electricity sales, high cost of natural gas, and increasing air emission controls in response to a global warming problem. Another future could be defined to include high electricity sales growth, low cost of natural gas, and no legislation requiring increased air emission controls. TVA created futures based on those uncertainties that could have the greatest impact on the resource strategies TVA might choose to implement. *Figure 2-5* illustrates how possible futures are created.

Step 5: Constructing Scenarios

A scenario is created by combining a single strategy for a single future. Each scenario can be discussed in terms of its relevant attributes and objectives. Scenarios are then evaluated using modeling and simulation techniques to measure their performance against the evaluation criteria.

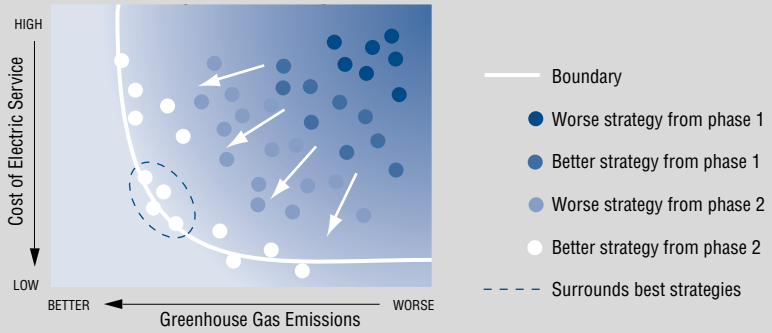
Step 6: Using Trade-Off Analysis to Find the Best Strategies for the Future

Once a set of feasible scenarios was developed, trade-offs among them were considered under the different futures. This trade-off analysis of scenarios was necessary because more than one evaluation criterion or measurement was relevant to evaluating the scenarios.

Discussions on trade-offs within TVA and with outside stakeholder representatives focused on how well various strategies might be able to meet selected evaluation criteria measurements. These discussions also considered what impacts the strategies might have on TVA's entire power system.

The purpose and nature of trade-off analysis are shown graphically in *Figure 2-6*. For illustration purposes, strategies were plotted in the trade-off graphs

FIGURE 2-6. **Using Trade-Off Analysis to Create Improved Strategies**



Better strategies were developed by analyzing trade-offs among various measures such as cost of electric service and greenhouse gas emissions. The strategies within the dotted line would be those with both the lowest electricity costs and the lowest greenhouse gas emissions.

for a given future. The axes of the graph identify two measures or attributes. In this example, the cost of electricity ($/kilowatt-hour) is on the vertical axis and greenhouse gas emissions (tons) are on the horizontal axis. The results for each strategy are plotted on the graph for given futures.

If there were only two evaluation criteria that TVA had to consider, the ideal strategy would be located closest to where the two axes meet (in the lower left hand corner). In this example, strategies within the dotted line would be those with the lowest electricity costs and the lowest greenhouse gas emissions.

Once trade-offs are initially analyzed (phase 1), strategies are modified and improved where possible (phase 2, etc.) to move them closer to the corner. In cases where an unavoidable trade-off exists, the decision-maker must choose between strategies. As an example, if there is no strategy with both the lowest costs and the lowest greenhouse gas emissions, the decision-maker may have to choose one over the other. After extensive reviews of different trade-offs among many pairs of evaluation criteria, those strategies that, in the opinion of the decision-maker, best meet the criteria and provide flexible choices are developed into the long-term resource plan. More information on the development of strategies and trade-offs can be found in Chapter 9.